Imperfect Bundling in Public-Private Partnerships

Luciano GRECO*

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Abstract

The economic literature on PPPs has often overlooked contractual incompleteness and agency problems within the private consortium (or Special Purpose Vehicle, SPV) joining the PPP. Taking into consideration such imperfections in bundling different tasks, SPV ownership structure becomes the main instrument to trade off the power of incentives of different private partners. Under imperfect bundling, the scope for welfare-improving PPP reduces, i.e., a stronger positive externality between investment and operation is required. Also, privately negotiated SPV ownership structures always involves less-than-socially-optimal shares to Builders. Thus, it is optimal for the government to impose minimum ownership requirements in PPP contracts.

Keywords: Public-private partnerships; special-purpose vehicle; incomplete contracts; asymmetric information

JEL classification: D8, L5, H54, H57

*Dipartimento di Scienze economiche, Università degli Studi di Padova, via del Santo 33 - 35123 Padova (Italy), luciano.greco@unipd.it.
1 Introduction

The global financial and economic crisis has caused a temporary decline in the value of PPP transactions during the last three years (EPEC, 2011). Nevertheless, the conventional wisdom is that the long-run trend in infrastructure financing and operation across countries features a steady growth of private sector involvement. A crucial role is played by complex contractual or institutional forms of public-private partnerships (PPPs) (Wagenvoort et al., 2010).

PPPs are characterized (and justified) by risk-transfer from the public to the private sector, aiming at improving the (investment and operation) efficiency of public infrastructures. These stylized facts allow us to recognize that some forms of PPPs have characterized investment in public infrastructures at least since the XIX century (e.g., the concession of construction and operation of bridges, railways, and so on). What distinguishes these old forms of PPPs from the new ones (that have been introduced in the last twenty years in many developed and developing countries) is the degree of legal and financial complexity of the latter. Let us consider, for example, the most prominent form of PPP, relying on the project finance technique. In this case, a number of firms and financial institutions legally establish a new company, or special-purpose vehicle (SPV), to carry out the project. All legal and financial obligations of the project are backed by future project revenues. The negotiation among involved firms and financial institutions hinges not only on the structure of the SPV but also on a web of sub-contracts aiming at redistribute risks and assigning tasks among all (private) partners (Yescombe, 2003).

This specific feature of PPPs has received little attention in the contract theory literature. Broadly speaking, the literature has contrasted Traditional Procurement
procedures with PPP agreements in which subcontracting relationships are (at least implicitly) assumed unaffected by incompleteness of contracts or imperfect information problems, that on the contrary affect the relations between the government and the private consortium. Based on such a setting, the economic literature on PPPs has clarified that the nature of efficiency gains afforded by PPPs arrangements is basically related to enhanced incentives to improve infrastructure quality because of the internalization - within the private consortium of firms participating in the PPP - of the positive effects of investment effort on operation efficiency (Hart, 2003; Iossa and Martimort, 2008).

Though many other issues have been addressed by the considered literature, namely how incomplete contracts and imperfect information affect the capacity of government to regulate the behavior of the private consortium, the bulk of such a literature has not yet considered the effects of incomplete contracting and asymmetric information within the consortium itself. As pointed out by Hoppe et al. (2011), once we consider the subcontracting relations between the main (or general) contractor and the government the result may diverge in a sensible way with respect to the standard analysis.¹

In this paper we provide a first contribution in this perspective. We adapt a simple PPP model (Hart, 2003; Iossa and Martimort, 2008) to account for a preliminary bargaining among private partners aiming at determining the decision-making rules and the main sub-contracting agreements. In this draft, we focus on the way imperfect bundling of tasks affects the performance of PPP with respect to TP, and the implications for optimal contracts between the government and the private con-

¹In particular, Hoppe et al. (2011) show through experimental treatments that contractual frictions among firms forming the consortium are likely to be relevant.
sortium. In a very simple setting à la Hart (2003), we find that ownership structure is the main instrument to regulate the incentives of main partners within the SPV. However, this fosters a fundamental trade off between improving the incentives of the Builder and those of the Operator. Because of this trade off, the scope for welfare improving PPPs, as compared to TP, is smaller than in the case of perfect PPPs. Also, the socially optimal ownership structure always involves a larger share to the Builder than the privately negotiated one. In turn, introducing minimum ownership constraints in PPP contracts improves the social welfare. A planned extension of the paper addresses the same question in a framework featuring imperfect information and financial constraints.

The paper is organized as follows: Section 2 introduces the theoretical setting; Section 3 analyzes our basic model involving imperfect bundling, focusing on private consortia made by Builders and Operators; Section 4 analyzes extensions to consider informational and financial constraints. Section 5 draws some concluding remarks.

2 The Model

We consider a simple public procurement model. A public infrastructure, once build, can be operated to provide a welfare-improving public service. The social welfare $S = S_0 + s \cdot (q - \alpha \cdot p)$ is assumed to be increasing in the public-infrastructure’s quality, $q$ ($s > 0$), and non-decreasing in operation-phase productive efficiency, $p$ ($\alpha \geq 0$). The investment (namely, design and build) costs $I = I_0 + q$ also increase in infrastructure’s quality; also, improving the infrastructure’s quality involves management (effort and) costs that, for the sake of analytical tractability, we assume equal to $i \cdot q^2$. The infrastructure’s operation costs $C = C_0 - (1 + \delta) \cdot q - p$ are
reduced by productive efficiency; again, the effort to pursue productive efficiency involves additional costs \( d \cdot \frac{e^2}{2} \); infrastructure’s quality may increase \((1 + \delta < 0)\) or decrease \((1 + \delta > 0)\) them, depending on the specific technology under consideration.

We assume that the Government (G) maximizes the social welfare. As usual, G has to compare traditional procurement (TP) procedures, featuring sequential contracting with different firms carrying out investment and operation, with public-private partnership (PPP) procurement (Figure 1). Under PPP procurement, G seals a single concession contract with a private consortium, typically gathering firms specialized in the different tasks (e.g., design, building, operation, financing) that are bundled in the PPP contract. To carry out the project, private consortium firms establish a company or special-purpose vehicle (SPV).

Whatever the procurement procedure, the infrastructure’s design and building has to be carried out through a firm featuring specific skills, a Builder (B). B is able to (possibly) imperfectly determine the infrastructure’s quality \( q = a + \eta \), where \( a \geq 0 \) is a quality-improving effort carried out by B in the design-and-construction phase and \( \eta \sim F(\eta) \) is a random disturbance to infrastructure’s quality, with \( E(\eta) = 0 \). Moreover, B may benefit of better (ex ante) information about the random component of infrastructure’s quality, during the design-and-construction phase (but after the bargaining phase): we assume that B observes the realization of \( \eta \) before choosing \( a \) with a probability \( \lambda_B \in [0, 1] \). We also assume that B maximizes its expected profit, trying to minimize the default risk (that cannot be perfectly insured).

In a similar fashion, the operation or public service provision phase has to be carried out through an Operator (O) performing specific skills. Productive efficiency during the operating phase \( p = e + \varepsilon \) is determined by the costly effort carried out by
O, $e \geq 0$, and by a random component $\varepsilon \sim H(\varepsilon)$, with $E(\varepsilon) = 0$. Before choosing $e$, the Operator observes the realized quality of the public infrastructure $q$ and, with a probability $\lambda_O \in [0, 1]$ observes the realization of $\varepsilon$. Also, O maximizes its expected profit, minimizing the default risk.

PPPs are featured by a relevant role of financial institutions, such as PPPs funds and investment banks. The main role of these institutions is providing needed money, given financial constraints faced by B and O. Thus, in the extended version of our model, we introduce one (or more) Financier(s) (F) providing the required capital to finance investments and operating capital. F can provide debt or equity to the project and maximizes its expected profits (assuming that risks is well diversified we will ignore default risk in this case). As pointed out in the literature (Dewatripont and Legros, 2005; Iossa and Martimort, 2008), the financing institution may also play a relevant role to enhance monitoring of project performance. We assume that, with probability $\lambda_F^P \in [0, 1]$, the Financier is able to detect if the Builder ($J = B$) or the Operator ($J = O$) have observed the shock hitting infrastructure’s quality and operating efficiency, respectively.

The main focus of our analysis is the bargaining process leading to the determination of private consortia structure, and its impact on the performance of alternative contractual arrangements as well as on the optimal structure of PPP relationship between G and the private consortium itself. Therefore, before the design-and-construction phase we analyze a bargaining process specifying the property rights on the SPV, and the allocation of risks and tasks. We assume that the involved parties define the property structure of the consortium on the basis of the Nash Bargaining solution.\footnote{The Nash Bargaining solution can be seen in this case as a reduced form of a negotiation} Upon the bargaining phase, sub-contracts with B and O are
The timing of the model in the benchmark case is represented in Figure 1.

3 Incomplete Contracts

As argued in the Introduction, financial contracts are a crucial feature of new PPPs. However, to understand the relevance of incomplete contracts and imperfect information within the private consortium, we first focus on a simplified setting where B and O choices are not affected by financial constraints. We start our analysis in a simple incomplete contracts setting à la Hart (2003).

To keep the analysis as simple as possible, in this Section, we assume that random components are irrelevant: \( \eta \) and \( \varepsilon \) have zero variance, thus \( q = a \) and \( p = e \). We continue to assume that B and O have specific skills in carrying out design-and-construction and operation phases, respectively. In this simplified setting, the first game among parties featuring a risk of bargaining disruption, with (potentially) asymmetric costs of disruption and values of outside options, driving bargaining power (Osborne and Rubinstein, 2005).
best benchmark, that is derived by the maximization of the net social welfare

$$\max_{\{a \geq 0, e \geq 0\}} S_0 + s \cdot (a - \alpha \cdot e) - I_0 - a - i \cdot \frac{a^2}{2} - C_0 + (1 + \delta) \cdot a + e - d \cdot \frac{e^2}{2}.$$  

Assuming that \(s \cdot \alpha \leq 1\) corner solutions are excluded, and the optimal investment in quality is \(a^{FB} = \frac{s + \delta}{i}\) and the optimal effort to improve operational efficiency is \(e^{FB} = \frac{1 - s - \alpha}{d}\).

Contract incompleteness is introduced assuming that \(a\) and \(e\) cannot be ex post verified, hence are ex ante non-contractible. Assuming that a sufficiently large number of B and O firms is available to undertake contracts with G, the procurement problem is easily analyzed. In the case of TP, G has to contract with B and then with O. Given that G and B cannot contract on \(a\), the optimal contract will be a fixed price contract, inducing zero investment in infrastructure quality, such that the price is equal to the basic investment \(T_B = I_0\) (Hart, 2003; Iossa and Martimort, 2008). In a similar way, by contract incompleteness about \(e\), also the operation contract is a fixed price one. Because \(e\) is privately worthy, but O does not take into account the negative effect of it on the social welfare, the optimal effort in this case is excessive, deriving by

$$\max_{e \geq 0} T_O - C_0 + (1 + \delta) \cdot 0 + e - d \cdot \frac{e^2}{2}$$

hence \(e^{TP} = \frac{1}{d} > e^{FB}\).

Under PPP with perfect bundling, G offers a contract to a single company acting as B and O. Again by contract incompleteness the contract is a fixed price one, but the private contractor is able to internalize the (positive) externality of the
investment phase on the operation phase. The private company in this case solves the problem

$$\max_{(a,e)} T_{PPP} - I_0 - a - i \cdot \frac{a^2}{2} - C_0 + (1 + \delta) \cdot a + e - d \cdot \frac{e^2}{2}$$

hence, $e^{PPP} = e^{TP}$ and $a^{PPP} = \frac{4}{i} < a^{FB}$ (or $a^{PPP} = 0$) when the investment in infrastructure’s quality involves a (sufficiently strong) positive externality, i.e., $\delta > 0$ (or, a negative externality, i.e., $\delta \leq 0$). Thus, the PPP solution with perfect bundling is equivalent to the traditional procurement one as regards production efficiency during the operation phase (which is excessive and reduces the value for money of the project), but may increase quality-enhancing investment in the investment phase. In particular, this is the case when infrastructure’s quality significantly reduces the operation costs ($\delta > 0$), while in the case of negative externality again zero investment in quality is reached.

### 3.1 PPP with Imperfect Bundling

The latter result is based on the strong assumption that bundling is perfect within the PPP private consortium. If this is not the case, or - as pointed out by Hoppe et al. (2011) - if we consider alternative settings where G deals with a general contractor who has to implement tasks through a sequence of subcontracts, these results do not hold any more. Under imperfect bundling (within PPP), we assume that private partners (and the SPV) face the same limitations as G in specifying contracts among them.

Given the incomplete contract setting, in the bargaining phase, B and O have to decide on the share of ownership of the SPV belonging to B (i.e., $b$) and to O
(i.e., 1 − b), but also on the subcontracting conditions. The sub-contracts cannot specify the level of effort (in terms of a or e), thus are fixed-price contracts, setting a payment for design-and-construction, $P_B$, and a payment for operation, $P_O$. Given these prices, the SPV has also to bear the operative costs, $C$. Therefore, the net profit of the SPV is

$$\Pi = T_{PPP} - P_B - P_O - C_0 + (1 + \delta) \cdot a + e$$

(1)

where $T_{PPP}$ is the payment from G to the SPV, and the consolidated profit (i.e., including the SPV’s dividend) of B and O are

$$\Pi_B = b \cdot \Pi + P_B - I_0 - a - i \cdot \frac{a^2}{2}$$

(2)

$$\Pi_O = (1 - b) \cdot \Pi + P_O - d \cdot \frac{e^2}{2}$$

(3)

respectively.

The level of subcontracts’ payments, and the property rights are determined in the bargaining phase.³ Once the bargaining process determines $\{b, P_B, P_O\}$, B and O carry out their tasks, choosing $a$ and $e$, respectively. Solving the game (see the branch PPP in Figure 1) by backward induction, O observes the level of $a$, and maximizes its profit (3): the optimal effort is found to be $e^{IB} = \frac{1 - b}{d}$, that for any $b > 0$ implies an effort strictly lower than under the TP procedure (and the PPP when bundling is perfect). Given that cost-cutting effort benefits only partially the

³This is what we observe in real world: the establishment of SPVs is characterized by a long and costly bargaining process aiming at determining all clauses that can actually be ex ante determined. Remark also that property rights regard only the value of the SPV, while the infrastructure, is assumed to be public. In the terms commonly used in the PPP literature, we focus on Build-Operate-Transfer schemes.
Operator, the incentive to bear such a cost is lower.

In a similar way, B maximizes its profit (2), determining the optimal level of
\[ a^{IB} = \frac{b(1+\delta)-1}{\delta} \quad (\text{or } a^{IB} = 0) \] if \( b \cdot (1 + \delta) \geq 1 \) (or \( b \cdot (1 + \delta) < 1 \)). Thus, for a sufficiently strong positive externality, i.e., \( \delta > \frac{1-b}{b} \) (where \( \frac{1-b}{b} > 0 \) whenever \( b < 1 \)), \( a^{IB} > a^{TP} = 0 \). However, the optimal level of quality-enhancing effort is strictly lower than in the case of a perfect PPP.

Anticipating the optimal level of \( a \) and \( e \) that B and O will decide in the investment and operation phases, B and O negotiate over the property and sub-contracting structure of the private consortium. The bargaining solution \( \{b^{IB}, P^B_{IB}, P^O_{IB}\} \) maximizes the Nash Product

\[
\max_{\{b,P_B,P_O\}} \Pi_B \cdot \Pi_O^{1-\gamma} \quad s.t. : \quad b \in [0, 1]
\]

where: by individual rationality, the disagreement profits are set to zero; \( \gamma \) is the bargaining power of B; and \( b \) is constrained between zero and one.

The bargaining solution crucially depends on \( a^{IB}(b) \) and \( e^{IB}(b) \) functions. In particular, we observed that \( a^{IB}(b) \) is discontinuous. First, consider the case when \( \delta \geq \frac{1-b}{b} \), hence \( a^{IB}(b) \geq 0 \). By the first order conditions of the Nash Product maximization, it is easy to check that corner solutions never arise. At the optimum, the payments \( P^B_{IB} \) and \( P^O_{IB} \) are such that

\[
\frac{\Pi_O}{\Pi_B} = \frac{1}{\gamma} - 1
\]
Also, the optimal SPV ownership structure is $b^{IB} = b(i_d, \delta)$, where

$$b(i_d, \delta) = \frac{1}{1 + \frac{i_d}{\delta(1+\delta)^2}} \quad (5)$$

Let us now turn to the case of $\delta < \frac{1}{b} - 1$, hence $a^{IB}(b) = 0$. While the optimization condition featuring the optimal payments $P^{IB}_B$ and $P^{IB}_O$ remains (4), it is straightforward to see that now the optimal SPV ownership structure is $b^{IB} = 0$.

Summing up the previous results, we can characterize the optimal bargaining solution among partners of the private consortium

**Proposition 1** Under imperfect bundling, the optimal PPP arrangements among private partners are such that:

1. the ratio between consolidated profits of partners depends just on their relative bargaining power, $\gamma$;

2. the ownership structure depends on the value of the externality between investment and operation phases, $\delta$, with a discontinuity at $\hat{\delta}(\frac{i}{d})$ (where $\hat{\delta}(\frac{i}{d}) \in (0, \frac{i}{d})$ and $\hat{\delta}' > 0$):

$$b^{IB} = \begin{cases} b(i_d, \delta) & \text{for } \delta \geq \hat{\delta}(\frac{i}{d}) \\ 0 & \text{otherwise} \end{cases}$$

**Proof.** The first statement derives by inspection of (4). As regards the second statement, remark that $b^{IB} > 0$ only if $a^{IB} \geq 0$, i.e., $b(i_d, \delta) \cdot (1 + \delta) \geq 1$. Let $\hat{\delta}(\frac{i}{d})$ be the value of $\delta$ such that $b(i_d, \delta) \cdot (1 + \delta) = 1$, or equivalently

$$\hat{\delta}(\frac{i}{d}) = \left\{ \delta \mid \delta \cdot (1 + \delta)^2 = \frac{i}{d} \right\};$$
therefore, \( \hat{\delta}(\frac{i}{a}) \in (0, \frac{1}{a}) \) and \( \frac{\partial \hat{\delta}(\frac{i}{a})}{\partial i} > 0 \); and the second statement follows.

It is worth highlighting the economic intuition underlying Proposition 1. As first, we see that the relative gains of partners are regulated by subcontract payments \( P_{IB} \) and \( P_{O} \). Quite interestingly, the ownership structure is used by private partners to regulate their (future) incentives as subcontractors of the SPV. To understand this, consider a comparative statics exercise on the ratio between the marginal costs of efforts in the operation and investment phases, i.e., \( \frac{i}{a} \). When \( \frac{i}{a} \) increases two effects take place: given \( \delta \), if \( b^{IB} \) is positive then its optimal level drops; moreover, \( \hat{\delta}(\frac{i}{a}) \) grows, reducing the scope for \( b^{IB} \) to be positive. The interpretation is straightfor-
ward, the ownership structure at the optimum plays only the role of regulating the strength of the incentives of (future) subcontractors, given that the level of (relative) profits can be regulated by means of subcontract payments. However, this role entails a fundamental trade-off between providing stronger incentives to the Builder or to the Operator. Thus, when the marginal cost of investing in infrastructure quality increases with respect to the marginal cost of cutting operating costs, it becomes less interesting for the consortium as a whole to invest in it. In turn, $b^{IB}$ has to drop. In the same vein, a stronger (positive) externality between investment and operation phases (i.e., private productivity of $a$) is required to make it interesting for the consortium to provide at least some incentives to the Builder.

### 3.2 Welfare Analysis and Optimal Public-Private Contract

The analysis of the previous section underlined the implication of dropping the assumption that PPP arrangements are unaffected by contract incompleteness. The introduction of such constraints does not determine clear-cut welfare effects. As first, we remark that the effort to reduce operating costs drops as $b$ increases. In particular, with $b^{IB} \in (0, s \cdot \alpha]$, the PPP under imperfect bundling is strictly welfare-improving with respect to TP (and to PPP under perfect bundling) as regards the level of $e$ (given that $e^O \geq e^{FB}$). Indeed, an imperfect PPP involves weaker cost-cutting incentives. Conversely, if $b > s \cdot \alpha$ we may have that $e$ is too low, and the social cost of this kind of (cost) inefficiency implies that PPP is worst than TP.

Potential welfare gains in the operation phase (with respect to perfect PPP) can come at the cost of welfare losses in the investment phase. In this case, if the externality between building and operating phases is positive, the optimal effort
to improve infrastructure’s quality is strictly higher than under TP procedure, but lower than what one would expect in the case of perfect bundling - unless $b^{IB} = 1$. In particular, under imperfect bundling, a strictly stronger positive externality (i.e., $\delta > \hat{\delta}(\frac{i}{d}) > 0$) is required to determine, at the bargaining equilibrium, sufficient incentives to B to improve infrastructure quality.

We now characterize the welfare effects of alternative ownership structures, i.e., $b \in [0, 1]$. It is easy to check that the social welfare function, depending on the ownership structures,

$$W^{IB}(b) = S_0 + s \cdot (a^{IB} - \alpha \cdot e^{IB}) - I_0 - a^{IB} - i \cdot \frac{a^{IB^2}}{2} + -C_0 + (1 + \delta) \cdot a^{IB} + e^{IB} - d \cdot \frac{e^{IB^2}}{2}$$

is concave in $b$; also, its first derivative is discontinuous at $b = \frac{1}{1+\delta}$, because of discontinuity of $a^{IB}$ in $b$.$^4$ Such a discontinuity implies a first critical value of $\delta$, that is relevant to determine socially optimal ownership structure:

$$\delta(\frac{i}{d}, s, \alpha) = \{\delta \mid \frac{(1 + \delta)^2 \cdot (s + \delta)}{1 - s \cdot \alpha \cdot (1 + \delta)} = \frac{i}{d}\}$$

(where $\frac{\partial \delta(\frac{i}{d}, s, \alpha)}{\partial s} > 0$, $\frac{\partial \delta(\frac{i}{d}, s, \alpha)}{\partial s} > 0$, and $\frac{\partial \delta(\frac{i}{d}, s, \alpha)}{\partial \alpha} > 0$).

A second critical value

$$\bar{\delta}(\frac{i}{d}, s, \alpha) = \frac{i}{d} \cdot \frac{1 - s \cdot \alpha}{s} - 1$$

(where $\frac{\partial \bar{\delta}(\frac{i}{d}, s, \alpha)}{\partial s} > 0$, $\frac{\partial \bar{\delta}(\frac{i}{d}, s, \alpha)}{\partial s} < 0$, and $\frac{\partial \bar{\delta}(\frac{i}{d}, s, \alpha)}{\partial \alpha} < 0$) is determined by first order

$^4$Remark that for values of $b$ below (or above) $\frac{1}{1+\delta}$, $a^{IB} = 0$ (or $a^{IB} \geq 0$).
conditions of the social welfare maximization and features the level of $\delta$ above which the positive externality becomes so strong that the best ownership structure (in terms of social welfare) involves full property to the Builder.\(^5\)

**Proposition 2** The socially optimal ownership structure is such that

1. if $\delta \geq \bar{\delta}(\frac{1}{s}, s, \alpha)$, $b^{SB} = 1$;

2. if $\delta \in (\hat{\delta}(\frac{1}{s}, s, \alpha), \bar{\delta}(\frac{1}{s}, s, \alpha))$, $b^{SB} = b(\frac{1}{s}, \delta) \cdot (1 + \frac{1}{1+\delta}) + (1 - b(\frac{1}{s}, \delta)) \cdot s \cdot \alpha$;

3. if $\delta < \hat{\delta}(\frac{1}{s}, s, \alpha)$, $b^{SB} = s \cdot \alpha$.

The proof follows by first order conditions of the Kuhn-Tucker maximization problem incorporating the discontinuity at $b = \frac{1}{1+\delta}$ and upper (1) and lower bounds (0) on $b$.

A first implication of Proposition 2 derives by comparison of the socially optimal ownership structure with the level of $b$ that comes out by private bargaining among B and O.

**Proposition 3** Under imperfect bundling, the socially optimal ownership structure always involves a larger share for the Builder than privately negotiated ownership structure.

**Proof.** By $\alpha \geq 0$, $\hat{\delta}(\frac{1}{s}) > \hat{\delta}(\frac{1}{s}, s, \alpha)$, thus for any $\delta < \hat{\delta}(\frac{1}{s})$ $b^{SB} \geq b^{IB} = 0$. For any $\delta \in [\hat{\delta}(\frac{1}{s}), \hat{\delta}(\frac{1}{s}, s, \alpha)]$, $b^{SB} = b(\frac{1}{s}, \delta) \cdot (1 + \frac{1}{1+\delta}) + (1 - b(\frac{1}{s}, \delta)) \cdot s \cdot \alpha > b^{IB}$. Finally, for any $\delta > \hat{\delta}(\frac{1}{s}, s, \alpha)$, $b^{SB} = 1 > b^{IB}$. \(\blacksquare\)

\(^5\)Remark that $\hat{\delta}(\frac{1}{s}, s, \alpha) > \bar{\delta}(\frac{1}{s}, s, \alpha) > 0$, whenever $\frac{1}{s} > \frac{\alpha^*}{1 + s \cdot \alpha^*}$. 

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The intuition of Proposition 3 is similar to what is traditionally found in the PPP literature: given that the private consortium (though imperfect) does not take into account the full benefits of investing in infrastructure quality (social externality), and does not consider the social costs of investing in operating cost cuts, the privately negotiated ownership structure is conceived to provide excessive incentives to the Operator and insufficient incentives to the Builder.

It is finally worth remarking that the social welfare associated to TP contracts is equivalent to the social welfare associated to PPP with imperfect bundling when \( b \) is fixed to zero, independently of the relevant parameters. By this reasoning, we can draw the following conclusion

**Corollary 4** Under imperfect bundling, the PPP contract weakly dominates the TP contract in terms of social welfare (strictly whenever \( \delta > \hat{\delta}(\frac{i}{\alpha}) \)).

**Proof.** The proof follows by the consideration that \( b^{SB} \geq b^{IB} \geq 0 \) and that the social welfare function is concave in \( b \). In particular, the social welfare function takes strictly larger values when \( b^{IB} > 0 \) (hence for \( \delta > \hat{\delta}(\frac{i}{\alpha}) \)).

Thus, the PPP with imperfect bundling is still a solution (strictly) improving the social welfare for sufficiently large positive externality between the investment and the operation phases (i.e., \( \hat{\delta}(\frac{i}{\alpha}) > 0 \)). A further improvement of the social welfare can be determined if the government is able to impose a minimum ownership share to the Builder in SPV, letting the negotiation among private partners to take place on the other relevant variables such as subcontracting payments.
4 Extensions: Informational and Financial Constraints

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5 Conclusion

The contract theory literature on PPPs has often considered a fundamental asymmetry between public-private contracting, i.e., contracts between the private consortia (or SPV) and the government, and contracting among private partners belonging to the SPV. The public-private contracts have been typically (and rightly so) assumed to be affected by contract incompleteness and/or information imperfection. On the other side, the effects of such imperfections have been overlooked as regards the second kind of contracts, among private partners.

In this paper, we showed that agency problems among private partners determine several important effects. As first, the ownership structure of SPV plays a crucial role in determining the balance between incentives of the consortium to pursue more strongly improvements in infrastructure quality or in operation X-efficiency. In turn, this implies that stronger positive externality between investment and operation is required to warrant welfare-improving PPPs. Furthermore, private negotiation will always deliver suboptimal ownership structures (from the point of view of the social welfare), given that only the private balance between costs of quality and efficiency are taken into consideration. Once additional social benefit of quality (or social costs of X-efficiency) enter the picture, we found that the socially optimal ownership structure should involve stronger incentives (i.e., ownership share) for the Builder.
An important policy implication of our work is that PPP contracts should introduce requirements on ownership structures, that are observable and contractible, while other features may not. This is partially in line with what we observe in real-world public procurement auctions, which often introduce similar requirements. An extension of such practices to PPP contracts should be taken into consideration.
References


EPEC (2011) *Market Update: Review of the European PPP Market in 2010*


